SYSTRON DONNER

INSTRUCTION MANUAL

This manual describes the HH Silicon Quater Rack Power Supplies. It contains information on the following:

Model HH15-3 OV
Model HH32-1.5 OV
Model HH50-1 OV
Model HH160-300

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HH SERIES
QUARTER RACK POWER
SUPPLIES
MODEL NO. HH15-3

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SECTION 1
DESCRIPTION

1.1 INTRODUCTION

The Silicon Quarter Rack Series power supplies are a flexible and dependable source of DC power, which can be used to meet a variety of needs. These needs may range in scope from inspection and production testing, to laboratory bench testing and systems applications.

The wide range of outputs available makes these units well suited for use as a basic laboratory power source. The ability to provide power packaged in minimum space with high reliability meets the demands of most systems requirements.

This insturction manual provides general characteristics and specifications, operating procedures, theory of operation, maintenance and troubleshooting, calibration, parts list and related schematics for the Models HH15-3 OV; HH32-15 OV; HH50-1 OV and HH160-300.

1.2 DESCRIPTION

These units are lightweight, compact and versatile. Their convenient quarter rack size permits them to be used in practically all areas of the laboratory. Utilizing all silicon semiconductors, there units will operate at their maximum temperature without derating.

Constant Voltage and Constant Current operation is provided with automatic crossover from one mode into the other. In the voltage mode, adjustable current limiting is provided while the current mode provides adjustable voltage limiting. A mode indicator light on the front panel indicates when the unit is operating in the constant current or current limiting mode. All units in this series have provisions for remote programming of voltage.

1.3 GENERAL FEATURES

Remote sensing, remote voltage programming, +60°C operation without derating, series or parallel operation, no turn on/turn off transients, overvoltage protection option and an all silicon design are featured in the HH Quarter Rack Series. Output, Sensing and Remote Programming terminals are located on a terminal board mounted on the rear panel of these units. The AC power switch, AC pilot lamp, current mode indicator lamp, current and voltage controls and appropriate metering devices are all located on the front panel. For convenience, additional output terminals have been provided on the front panel.

1.3.1 Constant Voltage Mode

A constant voltage is maintained across the output terminals at any preset value from zero to rated voltage output, provided that the load does not draw more than either the rated output current or more than the preset limiting current value determined by the front panel current control settings.

1.3.2 Constant Current Mode

Constant current operation is achieved by maintaining a constant voltage across an internal current sensing resistor. An automatic cross over network changes the mode of operation from Constant Voltage to Constant Current when the current demand reaches that of the preset current adjust control. The point at which the operating mode automatically changes is a function of variations in load conditions. The cross over point is adjustable, and can be established anywhere within the current and voltage range of the unit.

1.3.3 Automatic Current Limiting

Short circuit protection is provided by the Automatic Current Limiting circuit which limits the maximum output current under all load conditions. The point at which automatic current limiting occurs is variable, and may be selected anywhere between 5% of the rated current output and maximum rated current output of the unit. In the event of a short circuit, the output voltage will drop to zero, and will return to its previous level only upon removal of the short circuit.

1.3.4 Automatic Overvoltage Protection (Optional Feature)

Automatic Overvoltage (OV) protection is available as an option wherein special circuitry automatically tracks the programmed output voltage and prevents it from exceeding this output voltage. The voltage differential that will cause the OV to trip is approximately 10% or 1.5 volts above the programmed voltage. An internal sensitivity control is provided to desensitize the overvoltage protection circuit.

1.3.5 Remote Programming

Remote Programming is provided in the voltage mode of operation, and may be utilized over the entire voltage range of the unit. The scale factor for Remote Voltage Programming is 100 ohms per volt.

1.4 PRECAUTIONARY MEASURES

1.4.1 Wire Size

To assure proper regulation under all load conditions, and to prevent severe distortions of the AC line voltage, it is very important to take into consideration the physical size and current handling capabilities of the input power line. Serious losses in regulation and an increase in ripple may result from underrated or overloaded AC input lines. The maximum AC impedance from the breaker box to the power supply input should not exceed 0.75 ohms.

1.4.2 Voltage Regulator and Inverter Inputs

Do not use voltage regulators or inverters as a primary power source. The outputs of these devices are usually not sinusoidal in nature, and if used as the AC source for the power supply, will cause serious loss of regulation of the power supply output. Capacitive input filtering used for semiconductor power supplies requires charging to the peak of the rectified AC wave which non-sinusoidal AC sources cannot provide.

1.4.3 Variable Transformer Input

If a variable transformer is to be used to test the power supply for low and high AC line operation, it must be able to supply at least twice the VA requirements of the power supply and load.

1.4.4 Systems Considerations

In systems applications it is recommended that each power supply input power line be run separately to the AC distribution box, in order to minimize cross coupling and interaction between equipment. Do not run sensitive signal leads such as the remote sensing leads in the same cable as the AC input without shielding. It is strongly recommended that the AC input cables should not be run in close proximity to the output load cable leads, if minimum ripple is desired.

1.4.5 Terminal Post Resistance

All terminals and shorting links serving Outputs, Sensing and Programming must be securely tightened before use. Serious loss of regulation and an increase in ripple can result due to a voltage drop caused by loose terminals and shorting links.

The specifications cited herein for regulation and ripple can be readily attained on every power supply providing the proper method of measurement is employed. The major consideration is that the highly stable meter and oscilloscope, specified in the calibration procedures, must be connected to the sensing terminals and not the load terminals. The reason for this precaution is that the voltage drop between the load terminals and sensing terminals will yield an inaccurate regulation ripple measurement.

1.5 SPECIFICATIONS

Table 1-1 is a complete list of standard specifications for the HH Series Quarter Rack Power Supplies.

TABLE 1-1 SPECIFICATIONS

CONSTANT VOLTAGE MODE WITH ADJUSTABLE CURRENT LIMITING

Input: 105-125 VAC, 47-420 Hz. (200-240 VAC available.)

Output: Floating, isolated from ground, 300 VDC maximum.

	OUTPUT		
Model	Volts	Amps	Impedance*
HH15-3	0 to 15	0 to 3	0.002Ω
HH32-1.5	0 to 32	0 to 1.5	0.002Ω
HH50-1	0 to 50	0 to 1	0.002Ω
HH160-300	0 to 160	0 to 0.3	0.002Ω

*Nominal, DC to 1 kHz. Add $65 and suffix OV for Overvoltage Protection. (Not available on HH 160-300)

TABLE 1-1 SPECIFICATIONS (Cont'd)

CONSTANT VOLTAGE MODE WITH ADJUSTABLE CURRENT LIMITING (Cont'd)	
Regulation, Line:	0.01% or 2 mV*, for 105-125 VAC line change, at any output within specifications.
Regulation, Load:	0.01% or 3 mV*, no lead to full load at any output within specifications.
Ripple:	Less than 0.5 mV RMS.
Stability:	0.05% or 10 mV*, for 8 hours after warm-up. Measured at constant line voltage, load and ambient temperature.
Temperature Coefficient:	(0.02% +400 μV)/°C.
High Stability Option (X):	0.01% or 2 mV* with a T.C. of (0.01% +100 μV/°C.
Temperature Range:	0 to +60°C.
Recovery Time:	25 microseconds to within 0.05% or 15 mV* of output voltage, for 100% step change in rated load.
Short Circuit Protection:	Automatic Adjustable Current Limiting (ACL) variable from 5% to 100% of rated current.
AC Power Input Protection:	Fuse.
Remote Programming:	All units remotely programmable over output voltage range. Scale factor 100 ohms/volt, (except HH160-300 250 ohms/volt).
Remote Sensing:	Maintains rated regulation directly at the load. Maximum line drop 0.5 volts per leg.
Voltage Adjustment Range:	Continuously adjustable concentric vernier controls.
Overvoltage Protection (Internal Option):	Automatic fast acting overvoltage protection tracks the preset output voltage.
CONSTANT CURRENT MODE WITH ADJUSTABLE VOLTAGE LIMITING	
Current Output:	5% to rated current output.
Voltage Compliance:	0 to rated output voltage.
Regulation:	0.5% I_{rated} over full voltage range or for 105-125 VAC line change.
Ripple:	0.25% or 5 mA*.
Stability:	0.25% I_{rated}.
Temperature Coefficient:	0.1% I_{rated}/°C.

TABLE 1-1 SPECIFICATIONS (Cont'd)

GENERAL AND PHYSICAL SPECIFICATIONS	
Design Principle:	Precision Series Pass Regulation.
Operational Modes:	Constant Voltage with adjustable current limiting; Constant Current with adjustable voltage limiting; Automatic Crossover.
Mode Indicator:	Front panel mode indicator light indicates when supply is operating in the constant current or current limiting mode.
Controls:	
Voltage:	Coarse and Fine; 0 to rated output; front panel.
Current:	5% to 100% of rated output; front panel.
Input Power:	Front panel switch and indicator.
Metering:	
Voltage:	Front panel voltmeter.
Current:	Front panel ammeter.
Terminals:	
Front Panel:	Positive output (+V); Negative Output (-V); Ground (G).
Rear Panel:	(1) Negative Output -V; (2) Negative Sensing -S; (3-4-5) Remote Voltage Programming RVP; (6) Positive Sensing +S; (7) Positive Output +V; (8) Ground G.
Rack Mounting:	RHH-4 (mounts 4 HH units), RHH-3 (mounts 2 HH units and 1 HR unit). Blank filter panel PQ-1 also available. Must also use RAC-1 chassis.
Size:	4-1/4"W x 5"H x 15"D.
Weight:	13 lbs.

SECTION II - INSTALLATION AND OPERATION

2.1 MECHANICAL INSTALLATION

2.1.1 General

If the Silicon Quarter Rack Series power supply is to be used in a portable bench type configuration, no special mechanical installation is required. However, if the unit is to be rack mounted, special rack mounting adapters must be used to secure the unit to the relay racks. Triple mount (RHH-3) and quadruple mount (RHH-4) rack panel adapters are available.

2.1.2 Rack Panel Adapter Mounting

1) Remove the 6-32 screws which fasten the cover to the power supply chassis.

2) Remove and rotate the cover so that the front is now facing to the rear.

3) Fasten the cover securely in position with the 6-32 screws previously removed.

4) Attach the handles to the Rack Panel Adapter.

5) Stand the Rack Panel Adapter in front of the power supply. In order to mount the power supply properly, the top of the Rack Panel Adapter must face up. The top is distinguishable from the bottom in that all the holes, including those for the handles, are in a straight row across the front of the Rack Panel Adapter.

6) Attach the power supply to the Rack Panel Adapter with the 6-32 screws and lock washers provided.

2.2 ELECTRICAL CONNECTIONS

2.2.1 Input, Power:

A heavy duty 3 wire line cord and molded plug with grounding prong provides a path for input power to the unit.

The power handling ability of the AC power lines feeding AC power to the line cord must be considered, as serious losses in regulation and substantial increases in ripple can occur as a result of insufficient power handling capacity of these lines. The AC impedance from the breaker box to the power supply input connector should not exceed 0.75 ohms. All AC power line connections must be securely tightened, and any movable electric contact surface (such as the wiper arm of a variable transformer) should be kept clear of impedance producing oxide coatings.

Care should be exercised in selecting the proper wire size for the AC input lines. The figures listed in Table 2-1 will serve as a guide in making this selection.

TABLE 2-1 - AC INPUT WIRE SIZE

Length of Run (Single Lead)	Wire Size (AWG Standards)
10 feet or less	12
10 feet to 20 feet	10
20 feet to 50 feet	8
50 feet to 100 feet	6

2.2.2 Output, Rear Panel

An eleven terminal barrier strip mounted on the rear panel provides output, sensing, programming and ground connections. Table 2-2 SHORTING LINK APPLICATION, REAR PANEL, lists the various shorting link connections required for any of the various modes of operation.

2.2.3 Output, Front Panel

Three binding post terminals mounted on the front panel provide output (+V and -V) and ground (G) connections.

2.2.4 Front or Rear Panel Output Selection

Output voltage is available from either the front or rear panel terminals. However, while regulation is maintained at both terminals, the rated regulation is available from the rear terminal only.

2.2.5 Shorting Link Application, Rear Panel

The power supply is shipped from the factory with shorting links in place across terminals 1 and 2, 4 and 5, and 6 and 7 of the rear panel barrier strip. In this configuration, and with the load connected across the rear panel output terminals, local sensing and programming operation from the rear panel is provided. Connections for other configurations are shown in Table 2-2 SHORTING LINK APPLICATION, REAR PANEL.

TABLE 2-2 SHORTING LINK APPLICATION, REAR PANEL

Selection	Function	Connections Required
1	Local Sensing Local Programming	1 and 2; 6 and 7 4 and 5
2	Local Sensing Remote Programming	1 and 2; 6 and 7 3 and 4; PGM resistor across 4 and 5
3	Remote Sensing Local Programming	1 and 2 connected at load (-) 6 and 7 connected at load (+) 4 and 5
4	Remote Sensing Remote Programming	1 and 2 connected at load (-) 6 and 7 connected at load (+) 3 and 4; PGM resistor across 4 and 5

NOTE: If terminals 1 and 2 or 6 and 7 are left open, the output will become unregulated.

2.3 CONTROLS

2.3.1 Front Panel

TABLE 2-3 - FRONT PANEL CONTROLS

SYMBOL	NAME	FUNCTION
S1	AC POWER	Toggle switch, controls input power.
R29	VOLTAGE ADJUST (Coarse)	Potentiometer, adjusts voltage output.
R30	VOLTAGE ADJUST (Vernier)	Potentiometer, adjusts voltage output.
R39	CURRENT ADJUST (Coarse)	Potentiometer, adjusts current.

2.3.2 Internal

All internal control settings have been factory preset, and require no additional adjusting. However, if it should become necessary to adjust any of the internal controls due to circuit changes caused by component aging or replacement, refer to the calibration section of this instruction manual.

2.4 OPERATION

2.4.1 Control Settings

Set all front panel controls fully CW so that unit will operate in the Voltage rather than Current Limiting mode.

2.4.2 Shorting Links

If Local Sensing rather than Remote Sensing operation is desired, ascertain that shorting links are in place across the appropriate terminals.

2.4.3 Grounding

Either side of the Output may be grounded, or the Output may be used in a floating condition.

2.4.4 Power On

Connect the line cord to a nominal AC input power source. Set POWER switch S1 to AC-ON, and observe that pilot lamp DS1 glows.

2.4.5 Warm-Up

No warm-up time is necessary to place the unit into operation. However, a 30 minute warm-up period is recommended to reach rated stability.

2.4.6 Series Operation

To operate two or more power supplies in a series configuration, connect the output of each power supply in series. When operating in this mode, it is necessary to adjust the output of each unit independently. The output voltage is equal to the sum of the voltage settings of each power supply.

2.4.7 Parallel Operation

Two power supplies may be connected in parallel when a greater current than obtainable from a single power supply is required. The supplies that are to be connected in parallel need not have equal ratings nor be from identical Trygon series. One of the two supplies should be set to a slightly higher output voltage than that required, and their respective plus and minus terminals connected together as shown in Figure 2-1.

2.1.7 Parallel Operation (Cont'd)

To achieve remote sensing, in parallel connected supplies, connect the sensing leads of the lower voltage supply to the load.

The following are some precautions which must be noted in parallel operation:

(A) The inherent load regulation of the parallel connected supplies is equal to the nominal regulation of the individual supply plus the difference between the nominal voltage setting of the two supplies.

(B) When parallel-connected supplies are used in a systems application, it is advisable to turn on both units simultaneously. The inputs of both supplies should be connected to a single circuit breaker.

(C) When two supplies are operating in parallel, it is not advisable to set either voltage control near zero since this would cause severe damage to the control.

(D) If parallel operation of Trygon power supplies utilizing overvoltage (OV) protection is desired, the following steps should be followed:

1. Disconnect the gate lead from the OV SCR in one of the power supplies.

2. Initially, set the supply with the OV connected to a slightly higher voltage.

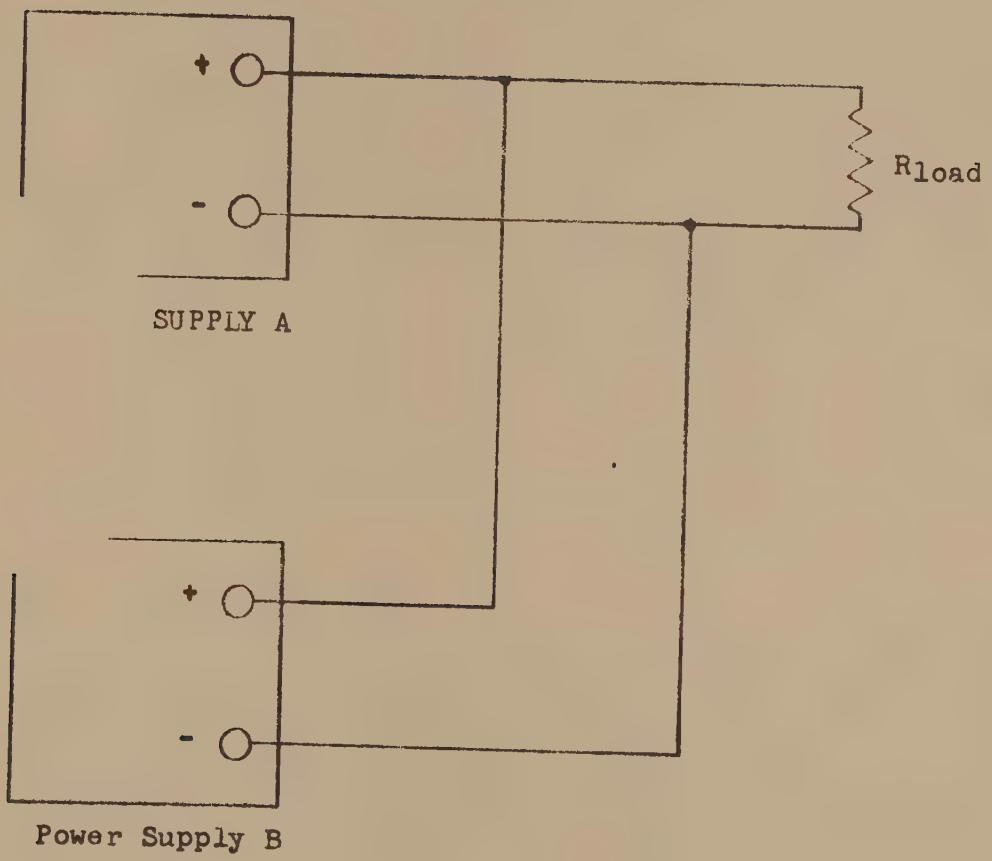

Figure 2-1.

SECTION III - THEORY OF OPERATION

3.1 GENERAL

The purpose of this power supply is to transform and rectify the AC input into a well regulated, stable and adjustable DC output. In performing these functions, the circuitry of the unit may be broken down into four basic sections, which shall be referred to in the following order:

1) Primary Input
2) Reference Supply
3) Series Regulator
4) Comparator and Error Amplifier

3.2 CIRCUIT ANALYSIS

The circuitry has been outlined in simplified form in the Block Diagram (Figure 3-1) located at the rear of this section. As each basic circuit is described, it will be advantageous to refer to the Block Diagram and the Schematic Diagram located at the rear of the Appendice Section of this instruction manual.

3.2.1 Primary Input

Input power is obtained through power transformer T1, full wave rectifier diode sets CR1 and CR2, CR10 and CR11, CR12 and CR13, and filter capacitor C1, C7 and C8. Each rectifier set provides the necessary DC voltages to the various sections of the unit.

When AC power switch S1 is set to AC ON, AC pilot lamp DS1 glows, and AC power is applied to the power transformer. Regulated DC output power is immediately available from the power supply.

3.2.2 Reference Supply

The rectified and filtered voltage from rectifiers CR1 and CR2 and filter capacitor C1 is pre-regulated by Coarse Reference Regulator zener CR3. This provides a stabilized DC voltage to Constant Current Source Q2, whose output is regulated by Precision Voltage Reference zener CR5. Constant Current Source Q1 controls the drive to Q2 and in turn is controlled by Q2. The voltages developed across Constant Current Source References CR4 and CR5 are highly stable reference voltages established at a higher positive potential than the positive output of the supply.

3.2.3 Series Regulator

The DC voltage from diodes CR10 to CR13 is directed through the Series Pass transistors. The conduction of these transistors is controlled by circuitry which causes them to act as variable resistors. Their overall resistance varies in accordance with the need of the power supply to increase or decrease its output voltage or current.

To dissipate power within the Series Pass circuit when power is not being fed into a load, large current handling "throw off" resistors are placed in parallel with the Series Pass transistors. The throw off resistors are placed in a location remote from the Series Pass transistors, to reduce heat concentration and increase transistor life and reliability.

The Series Pass transistors are controlled by several driver stages which amplify signals from the error amplifier.

3.2.5 Comparator and Error Amplifier

The voltage sensing and comparison is accomplished by differential amplifier Q10. A sample of the output voltage on the base of Q10 is compared to the stable reference voltage on the base of comparator Q9. An unbalance caused by a change in voltage at either the negative sensing terminal or across voltage

3.2.5 Comparator and Error Amplifier (Cont'd)

adjustment controls R29 and R30 will appear as a voltage change in the collector of Q10.

This difference voltage is amplified by error amplifier Q6, and is used to regulate the Series Pass transistors via the Series Pass drivers. Error amplifier Q6 has two diode inputs to its base which form an OR gate for error signals. CR7 supplies error signals from the comparator, and CR6 supplies an error signal in the event of a short circuit, or if the power supply is driven into the current limiting mode of operation.

When operating in the current limiting mode, differential amplifier Q3 and Q4 become balanced, causing diode CR6 to conduct, and in turn drives error amplifier Q6 toward cut-off. This signal also causes Q7 to conduct, thereby causing current mode indicator lamp DS2 to glow.

3.3 OPTIONAL FEATURES

3.3.1 Overvoltage (OV) Protection

If the output voltage should rise above the programmed output level, a portion of the signal developed across the OV Sensitivity control will cause the OV Sensor to conduct, which in turn drives the OV Reference into conduction. The output of the OV SCR Driver is applied to the gate lead of the OV SCR, causing it to "fire". "Firing" of the OV SCR cuts off the Series Pass drivers and in turn, the Series Pass circuit.

If the overvoltage condition is caused by a short in the Series Pass circuit, the OV SCR will "fire", causing the OV fuse to open.

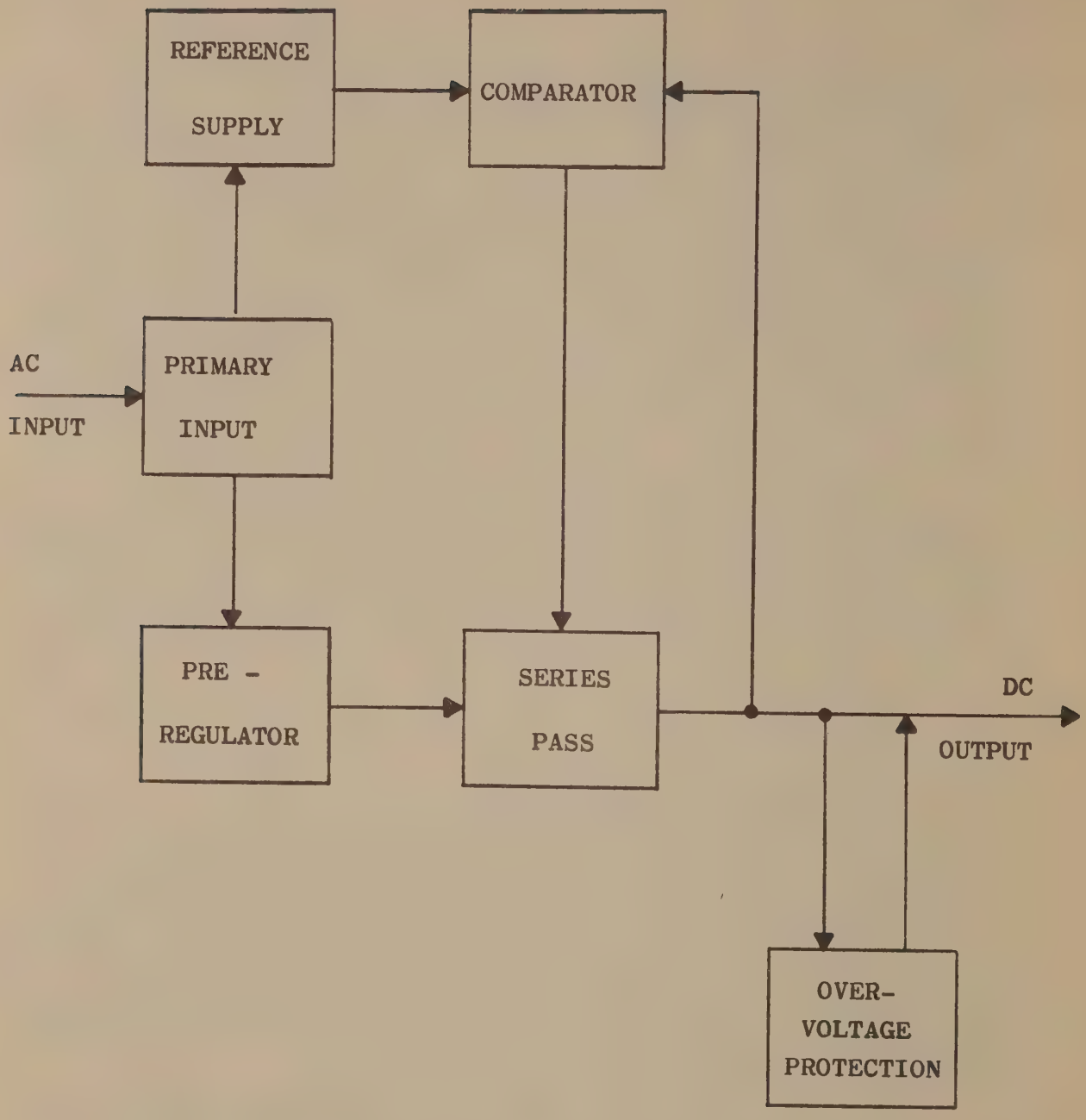

FIGURE 3-1 - BLOCK DIAGRAM

SECTION IV - MAINTENANCE

- W A R N I N G -

High Voltages Are Present
Use Caution

4.1 GENERAL

This power supply is a precision instrument. It is strongly recommended that only experienced troubleshooting personnel perform troubleshooting operations or attempt to repair the unit. If the power supply appears to be malfunctioning at all, the following procedure is recommended for isolating possible defects.

4.2 LOADS AND INTERCONNECTIONS

1. Disconnect all interconnections and loads to which the unit is normally connected.
2. Place shorting links between rear panel terminals 1 and 2, 4 and 5, and 6 and 7. These connections must be securely made, or deterioration of output regulation will occur.
3. Connect a resistive dummy load across output terminals +V and -V. This load should be of sufficient value to allow the unit to operate at its maximum rated current and voltage output.
4. Apply nominal AC input power to the unit and check for normal operation. Satisfactory operation at this time would indicate that any malfunction previously encountered, is external in nature. All

4.2 LOADS AND INTERCONNECTIONS (Cont'd)

interconnections and loads normally used in conjunction with this power supply should then be carefully checked for electrical defects.

4.3 TROUBLESHOOTING

1. Set VOLTAGE ADJUST and VOLTAGE VERNIER controls fully CW. Using a 20,000 ohms per volt voltmeter or oscilloscope, check the voltages across the various circuit components listed in the TROUBLESHOOTING GUIDE, located immediately before the schematic diagram at the rear of this instruction manual. The sample voltages listed in this guide apply only if the unit is operating at its nominal AC input, and has a dummy load of sufficient size connected across its output to allow operation at maximum rated current and voltage output levels. Any reading which is grossly incorrect indicates that the stage being tested or the one immediately preceding it, is defective. The Block Diagram, Schematic Diagram and appropriate sections of the Theory of Operation will prove helpful in any troubleshooting work. Proper polarity to be observed when testing can be easily obtained from the Schematic Diagram.

2. If voltage checks show no noticeable deviations from the prescribed values, disconnect AC power and proceed with point to point resistance checks across pots, switches, diodes, resistors, transistors in that order.

3. When the trouble is of an intermittent nature such as poor regulation, ripple etc., the use of an oscilloscope to determine dynamic changes will be necessary.

4.3 TROUBLESHOOTING (Cont'd)

The section on Theory of Operation should be consulted to determine circuit performance with varying output conditions.

SECTION V - CALIBRATION

5.1 GENERAL

The following adjustments should be made when necessary to assure optimum operating characteristics and maximum efficiency of the Trygon power supply.

5.2 TEST EQUIPMENT REQUIRED (or equivalent)

(A) Oscilloscope, Tektronix Type 561
(B) Differential Amplifier Plug In, Tektronix Type 63
(C) Time Base Plug In, Tektronix Type 67
(D) Differential VTVM, Fluke Model 825A
(E) AC VTVM, Hewlett Packard Model 400D
(F) VOM, Simpson Model 260
(G) Variable Auto transformer, Powerstat Type 3PN136 (20 Ampere rating)

5.2.1 Shorting Link Application

For test purposes, shorting links should be connected across terminals 1 and 2, 4 and 5 and 6 and 7 to provide local sensing and local voltage programming. To reduce pick up, shielded wire must be used for all connections between test equipment and the power supply being tested. To prevent ground loops, it is important that only one ground connection be made, as shown in Figure 5-1 and Figure 5-2. Tighten all terminal connections as securely as possible, and set all front panel controls fully CW.

5.3 CALIBRATION PROCEDURE

5.3.1 Voltage Adjust Control

5.3.1 Voltage Adjust Control (Cont'd)

A) Maximum Voltage

Set front panel VOLTAGE ADJUST and VOLTAGE VERNIER controls fully CW. Adjust Maximum Voltage control R24 to obtain an output voltage 0.5 VDC in excess of the maximum rated output voltage.

B) Minimum Voltage

Set front panel VOLTAGE ADJUST and VOLTAGE VERNIER controls fully CCW. Adjust Minimum Voltage control R28 to obtain a negative output voltage of 0.1 VDC.

C) Readjustment

Adjustment of either Maximum Voltage control R24 or Minimum Voltage control R28 will have an effect upon the other. Therefore, these controls should be readjusted if necessary, as outlined in preceding paragraphs 5.3.2 (A) and (B), upon initial completion of this adjustment.

NOTE

If partial rotation of the VOLTAGE ADJUST controls produces no apparent change in indicated output voltage, further rotation of these controls should not be attempted. Rotation of these controls fully CCW with little or no output voltage regulation can result in damage to the controls, the load, or both. Set the AC POWER switch to OFF, and proceed with the troubleshooting outlined in Section IV (MAINTENANCE) of this instruction manual.

Set front panel VOLTAGE ADJUST and VOLTAGE VERNIER controls fully CCW and observe that the voltage indicated on the unit and test voltmeters drops slightly below the zero setting of the meters. The output voltage should be approximately negative 200 MV. Reset voltage controls fully CW.

5.3.2 Current Adjust Controls

A) Maximum Current

Connect a test ammeter having a full scale current indicating capacity of 150% that of the rated current output across the output terminals of the power supply. (Set all front panel controls fully CCW). Apply power to the unit under test and slowly rotate CURRENT ADJUST control fully CW. Observe that the maximum current obtainable is approximately 105% that of the maximum rated current output. If it is not possible to achieve 105% of the maximum rated current output, adjust Maximum Current control R41 until that value is attained. Set AC Power Switch to OFF.

Connect a suitable load resistance across the output terminal connections. The load resistance must be able to dissipate the rated power of the unit (P = IE) and must be of sufficient value to yield the rated output current when the rated voltage is applied. Set AC Power Switch to ON. Note the voltage indicated on the Differential VTVM. Disconnect the resistive load from the output and observe the voltage indicated on the Differential VTVM. The maximum change in output voltage should not exceed by more than 0.01% or 3 mv (whichever is greater) that of the output voltage indicated with the load resistance applied across the output terminals.

If it is not possible to maintain the load regulation as stated in the preceding paragraph, readjust Maximum Current control R41 slightly and recheck the load regulation.

5.3.3 Constant Voltage Operation

A) Load Regulation

5.3.3 Constant Voltage Operation (Cont'd)

With the equipment connected as shown in Figure 5-1, connect a suitable load resistance across the Output terminal connections. The load resistance selected must be able to dissipate the rated power of the unit (P = IE) and must be of sufficient value to yield the rated output current when the rated voltage is applied. Note the voltage indicated on the Differential VTVM. Disconnect the resistive load from the output. The maximum change in output DC voltage indicated on the Differential VTVM should not exceed by more than 0.01% or 3 mv (whichever is greater) that of the output voltage indicated with the load resistance applied across the output terminals.

B) Line Regulation

Place the resistive load across the output and note the voltage indicated on the Differential VTVM. Vary the AC input power 10% above and below the nominal AC input level. The maximum change in output voltage should not exceed by more than 0.01% or 2 mv (whichever is greater) that of the output voltage measured at either extreme of the AC input.

C) Ripple Voltage

In order to reduce pickup, shielded test leads should be used in making ripple measurements. With the resistive load connected across the output terminals, measure the AC ripple with the AC VTVM. Vary the AC input power 10% above and below the nominal AC input level. The maximum ripple amplitude should not exceed 0.5 mv RMS.

5.3.4 Constant Current Operation

A) Load Regulation

With the equipment turned off, disconnect the resistive load from the output terminals. Connect a small current sensing resistor in series with the resistive load and then connect the load back across the output terminals. Selection of the proper value for the current sensing resistor may be easily made using the formula $R_S = \frac{I}{I_R}$ where R_S = Value of Current Sensing Resistor and I_R = Rated Load Current. Connect the equipment as shown in Figure 5-2, and apply power to the power supply.

Vary the VOLTAGE ADJUST controls and resistive output load as necessary, to achieve rated current and voltage output. Decrease the load resistance until current meter reading exceeds full scale indication. Rotate CURRENT ADJUST control CCW to return the current meter reading to full scale. Observe that the output voltage has decreased from its previous full scale reading, and that increasing the VOLTAGE ADJUST controls has no effect upon the output voltage or current. This indicates that the unit is now operating in the Constant Current mode.

5.3.5 Overvoltage (OV) Sensitivity (Optional)

The sensitivity of the Overvoltage Protection circuit is determined by the setting of the Overvoltage Sensitivity control. This control is factory preset to cause a short circuit to be applied across the output of the unit if the output voltage attempts to rise more than 5% or 1.5 volts above the programmed voltage.

Although an internal control, the OV Sensitivity control is not "solder locked" in place as are the other internal controls, but may be varied to suit the individual needs of the

5.3.5 Overvoltage (OV) Sensitivity (Optional) (Cont'd)

user. This control may be varied from outside the unit by inserting a screwdriver through one of the ventilation holes in the top of the power supply case.

To determine the proper point at which the OV Sensitivity control should be set to automatically shut the unit off, connect the output of a second power supply having a higher output voltage capability, in parallel with the unit under test. Set the output of the second unit 10% higher than that of the first unit. Adjust the OV Sensitivity control until the unit under test automatically shuts itself off.

5.3.6 Test Set-Up

The equipment should be connected as shown in Figures 5-1 or 5-2 for testing in either the Constant Voltage or Constant Current modes of operation.

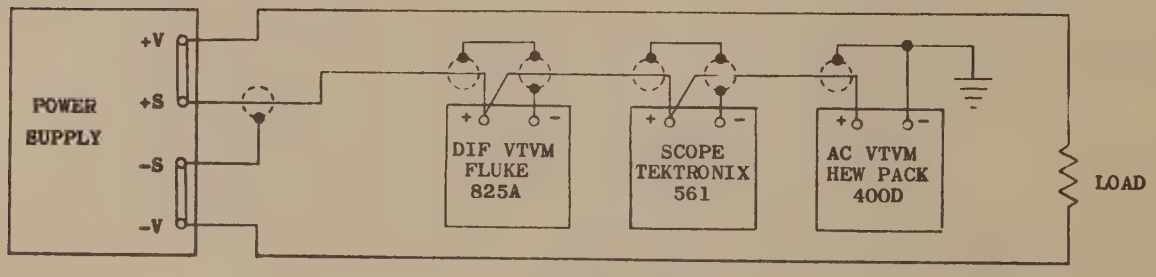

FIGURE 5-1
CONSTANT VOLTAGE OPERATION

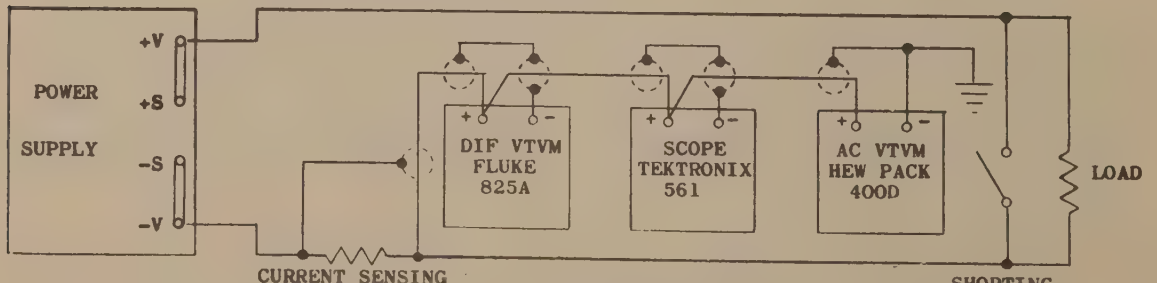

FIGURE 5-2
CONSTANT CURRENT OPERATION

E L E C T R I C A L P A R T S L I S T -- HH15-3V

REFERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK #
C 1	CAP 500MF 75V 39D	56289	39D507G075HL4	810223
C 2	CAP 801 MF 600V 811Z5V103P	33498	ACOM GP103P	800090
C 3	CAP .0033MF 600V CK62AW332	33498	GP332K	800025
C 4	CAP .001MF 600V CK62BX102M	33498	GP102M	800006
C 5	CAP 801 MF 600V 811Z5V103P	33498	ACOM GP103P	800090
C 6	CAP 10MF 50V TTXE	90210	TTX106N050A0LTP	810010
C 7	CAP 68MF 50V 76F02LN680	00853	TYPE 556	810080
C 8	CAP 6000MF 35V W/MYLAR 86E	09835	DRWG	820274
C 9	CAP 3000MF 25V 39D	56289	39D	819970
C 10	CAP 10MF 50V TTXE	90210	TTX106N050A0LTP	810010
C 11	CAP 34MF 15V TYPE TTXE	90201	TTXE	810057
C 12	CAP .001MF 600V CK62BX102M	33498	GP102M	800006
C 17	CAP .05MF-200V	33498	LTGP503M	800168
CR 1	DIODE ZENER IN4384	14936	G100G110	720384
CR 2	DIODE ZENER IN4384	14936	G100G110	720384
CR 3	DIODE IN1360A	81483	1N1360A	720241
CR 4	DIODE ZENER IN 751 A	81483	1N751A	720181
CR 5	DIODE 1N2163A	24444	IN2163A	720262
CR 6	DIODE ZENER IN4384	14936	G100G110	720384
CR 7	DIODE ZENER IN4384	14936	G100G110	720384
CR 8	DIODE ZENER IN4384	14936	G100G110	720384
CR 9	DIODE ZENER IN4384	14936	G100G110	720384
CR 10	DIODE 12 AMP 50V	22888	DRWG	720129
CR 11	DIODE 12 AMP 50V	22888	DRWG	720129

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ELECTRICAL PARTS LIST -- HH15-3V

REFERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK #
CR 12	DIODE ZENER IN4384	14936	G100G110	720384
CR 13	DIODE ZENER IN4384	14936	G100G110	720384
CR 14	DIODE ZENER IN4384	14936	G100G110	720384
CR 15	DIODE ZENER IN4384	14936	G100G110	720384
CR 16	DIODE ZENER IN 751 A	81483	1N751A	720181
CR 17	DIODE ZENER,IN4384	14936	G100G110	720384
CR 27	DIODE 1N4384	14936	G100G110	720384
DS 1	PILOT LIGHT REDLENS	91802	2110814	770028
DS 2	LIGHT IND 41N 66 1317 9RST	91802	2190A87	770023
F 1	FUSE 3A MDL 125V	71400	MDX3	870180
M 1	METER 3A EXT	33005	MS1T	750310
M 2	METER 15V	33005	MS1T	752610
P 1	LINE CORD 18-3	*		921000
Q 1	TRANS 16A507-2N2714	03508	2N2714	700180
Q 2	TRANS 2N2905A	04713	2N2905	705067
Q 3	TRANS 16A507-2N2714	03508	2N2714	700180
Q 4	TRANS 16A507-2N2714	03508	2N2714	700180
Q 5	TRANS 16A507-2N2714	03508	2N2714	700180
Q 6	TRANS 2N2905A	04713	2N2905	705067
Q 7	TRANS 16A507-2N2714	03508	2N2714	700180
Q 8	TRANS 16A507-2N2714	03508	2N2714	700180
Q 9	TRANS 16A507-2N2714	03508	2N2714	700180
Q 10	TRANS 16A507-2N2714	03508	2N2714	700180
Q 11	TRANSISTOR TR 1490	30045	PRINT	700080

E L E C T R I C A L P A R T S L I S T -- HH15-3V

REFERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK #
Q 12	TRANSISTOR TR 1490	30045	PRINT	700080
Q 13	TRANSISTOR TR1591	30045	ORWG	700191
Q 14	TRANS 2N2219A-SPEC	05828	2N2219A	705068
R 1	RWW 200& 5& WW5& 5X20		VALS	640389
R 2	RMF 9&95 K &5 W 1 CECT	12126	M1/2TI	620600
R 3	RCOMP 47& K &5 W10 RC2	01121	RCR20	610340
R 4	RMF 1&18 K &5 W 1 CECT	12126	M1/2TI	620320
R 5	RMF 150 &5 W 1 CECT	12126	M1/2TI	620050
R 6	RMF 750 &5 W 1 CECT	12126	M1/2TI	620250
R 7	RMF 750 &5 W 1 CECT	12126	M1/2TI	620250
R 8	RCOMP 100 .5W 10 RC2	01121	RC20	610070
R 9	RMF 750 &5 W 1 CECT	12126	M1/2TI	620250
R 10	RMF 1&96 K &5 W 1 CECT	12126	M1 1/2 T1	620402
R 11	RCOMP470& &5 W10& RC2	01121	RCR20	610140
R 12	RCOMP 4&7 K &5 W10 RC20	01121	RC20	610250
R 13	RCOMP 1 K &5 W10& RC2	01121	RC20	610180
R 14	RCOMP 10& K &5 W10 RC2	01121	RC20	610290
R 15	RCOMP100& K &5 W10 RC2	01121	RCR20	610350
R 16	RCOMP560& &5 W10& RC2	01121	RCR20	610150
R 17	RMF 402 &5 W 1 CECT	12126	M1/2TI	620140
R 18	RMF 1&5 K &5 W 1 CECT	12126	M5T1	620360
R 19	RMF 750 &5 W 1 CECT	12126	M1/2TI	620250
R 20	RMF 1&96 K &5 W 1 CECT	12126	M1 1/2 T1	620402
R 21	RMF 1&96 K &5 W 1 CECT	12126	M1 1/2 T1	620402

REFERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK #
R 22	RCOMP 330Ω .25 W10% RC2	01121	RC20	610120
R 23	RMF 750 .25 W 1 CECT	12126	M1/2TI	620250
R 24	POT 150 .125 W 110	11236	DRWG 099030-3	600071
R 25	RMF 511 .25 W 1 CECT	12126	M1/2TI	620180
R 26	RMF 200 .25 W 1 CECT	12126	M1/2TI	620070
R 27	RLTC 50Ω .38 W 39 1300	83125	1300S	630220
R 28	POT 150 .125 W 110	11236	DRWG 099030-3	600071
R 29	POT 1.5K 100 2W DUAL	12697	PRINT	605018
R 30	POT 1.5K 100 2W DUAL	12697	PRINT	605018
R 31	RWW 1K 10W 5 LUG FR 10	NGN	FR10	640521
R 32	RWW 400 5W 5 5X	NGN	VAL5	640434
R 33	RCOMP 470Ω .25 W10% RC2	01121	RCR20	610140
R 34	RCOMP 1 K .25 W10% RC2	01121	RC20	610190
R 35	RCOMP 2R2 K .25 W10% RC20	01121	RC20	610210
R 36	RCOMP 470Ω .25 W10% RC2	01121	RCR20	610140
R 37	RWW 9 100W RR 100	82807	12-56-9R X	650295
R 38	RCOMP 100 .5W 10 RC2	01121	RC20	610070
R 39	POT 125 2 W10 R164	12697	DWG	600060
R 40	RMF 374 .25W 1 CECTO	12126	M1/2T1	620135
R 41	POT 500 .125 W 110	11236	DRWG 099030-5	600146
R 42	RWW .33 25W 20PPM 2		FR25	650065
R 43	RMF 604 .25 W 1 CECT	12126	M1/2TI	620210
R 44	POT 150 .125 W 110	11236	DRWG 099030-3	600071
S 1	SWITCH DPST 2BK63 73		ATL SWITCH 2BK63 73	880090

E L E C T R I C A L P A R T S L I S T -- HH15-3V

REFERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK #
T 1	X FORMER	09206	PRINT	509035

* ANY GOOD COMMERCIAL GRADE ELECTRICAL EQUIVALENT WHICH IS READILY AVAILABLE MAY BE USED.

E L E C T R I C A L P A R T S L I S T -- HH15-30V

REFERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK #
C 15	CAP .0047 250V		MKT1813	800147
C 16	CAP .15MF 250V		MKT1813	800210
CR 20	DIODE ZENER IN 751A	81483	1N751A	720181
CR 21	DIODE ZENER IN4384	14936	G100G110	720384
CR 22	DIODE ZENER IN4384	14936	G100G110	720384
CR 23	DIODE ZENER IN4384	14936	G100G110	720384
CR 24	DIODE 12 AMP 50V	22888	DRWG	720129
CR 25	SCR C30F	0 81093	16C050C	720015
F 2	FUSE 5A 32V AGC	71400	AGC32V	870070
Q 20	TRANS 16A507-2N2714	03508	2N2714	700180
Q 21	TRANS 2N2905A	04713	2N2905	705067
Q 23	TRANS 2N2905A	04713	2N2905	705067
R 50	RMF 185 K 85 W 1 CECT	12126	MFT1	620350
R 51	RCOMP 470 85 W10 8 PC2	01121	RCB20	510140
R 52	RCOMP 100 K 85 W10 PC2	01121	RC20	510290
R 53	RCOMP 487 K 85 W10 RC20	01121	RC20	510250
R 54	RCOMP 1 K 85 W10 8 PC2	01121	RC20	510180
R 55	POT 5 K 185 W20 110 P	11236	DRWG 089030-10	600290

* ANY GOOD COMMERCIAL GRADE ELECTRICAL EQUIVALENT WHICH IS READILY AVAILABLE MAY BE USED.

E L E C T R I C A L P A R T S L I S T -- HP50-1.0

REFERENCE	COMPONENT			MFR	MFR PART NUMBER	STOCK #
C 1	CAP 500MF 75V 390			56289	39D507G075HL4	810223
C 2	CAP 8017F 600V			33498	ACOM GP103P	800090
C 3	CAP 80033MF 600V	CK62AW332		33498	GP332K	800025
C 4	CAP 8001M600V			33498	GP102M	800006
C 5	CAP 8017F 600V			33498	ACOM GP103P	800090
C 6	CAP 1.0MF 150V			90201	TTX106N050A0LTP	810060
C 7	CAP 21 MF 125V			90201	TTXF	810541
C 8	CAP 1300MF 85V			90201	PRINT	820080
C 9	CAP 500MF 75V 390			56289	39D507G075HL4	810223
C 10	CAP 1.0MF 150V			90201	TTX106N050A0LTP	810060
C 11	CAP 34MF 15V TYPE TTXF			90201	TTXF	810557
C 12	CAP 8017F 600V			33498	ACOM GP103P	800090
CR 1	DIODE ZENER	IN4384	D	14936	G100G110	720384
CR 2	DIODE ZENER	IN4384	D	14936	G100G110	720384
CR 3	DIODE IN1360A			81483	1N1360A	720241
CR 4	DIODE ZENER IN 751A			81483	1N751A	720181
CR 5	DIODE 1N2163A			24444	TN2163A	720262
CR 6	DIODE ZENER	IN4384	D	14936	G100G110	720384
CR 7	DIODE ZENER	IN4384	D	14936	G100G110	720384
CR 8	DIODE ZENER	IN4384	D	14936	G100G110	720384
CR 9	DIODE ZENER	IN4384	D	14936	G100G110	720384
CR 10	DIODE 12 AMP 200V			81093	DRWG	720131
CR 11	DIODE 12 AMP 200V			81093	DRWG	720131
CR 12	DIODE ZENER	IN4384	D	14936	G100G110	720384

REFERENCE	COMPONENT		MFR	MFR PART NUMBER	STOCK #
CR 13	DIODE ZENER	IN4384	0 14936	G100G110	720384
CR 14	DIODE ZENER	IN4384	0 14936	G100G110	720384
CR 15	DIODE ZENER	IN4384	0 14936	G100G110	720384
CR 16	DIODE ZENER IN 751A		81483	1N751A	720181
CR 17	DIODE ZENER	IN4384	0 14936	G100G110	720384
CR 18	DIODE TR 4148		21845	1N4148	720440
CR 27	DIODE 1N4384		14936	G100G110	720384
DS 1	PILOT LIGHT REDLENS		91802	2110P14	770028
DS 2	LIGHT IND 41N 66 1317 98ST		91802	2190A87	770023
F 1	FUSE 5AMP		75915	MDX	870190
M 1	METER 1A-EXT-MS1T		33005	MS1T	750299
M 2	METER 60 VOLT-MS1T		33005	MS1T	752631
P 1	LINE CORD 18-3		*		921000
Q 1	TRANS 2N 2714-16A507		03508	2N2714	700180
Q 2	TRANS 2N2905A		04713	2N2905	705067
Q 3	TRANS 2N 2714-16A507		03508	2N2714	700180
Q 4	TRANS 2N 2714-16A507		03508	2N2714	700180
Q 5	TRANS 2N 2714-16A507		03508	2N2714	700180
Q 6	TRANS 2N2905A		04713	2N2905	705067
Q 7	TRANS 2N 2714-16A507		03508	2N2714	700180
Q 8	TRANS 2N 2714-16A507		03508	2N2714	700180
Q 9	TRANS 2N 2714-16A507		03508	2N2714	700180
Q 10	TRANS 2N 2714-16A507		03508	2N2714	700180
Q 11	TRANSISTOR		30045	DRWG	700085

REFERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK #
Q 12	TRANSISTOR	30045	DRWG	700085
Q 13	TRANSISTOR	21845	PRINT	700195
Q 14	TRANS 2N2219A R SPEC	05828	2N2219A	705068
R 1	RWW 200R 5P WW58 5X20		VALS	640389
R 2	RMF 9895 K 85 W 1 CF CT	12126	M1/2TI	620600
R 3	RCOMP 47R K 85 W10 RC2	01121	RCR20	610340
R 4	RMF 750 85 W 1 CF CT	12126	M1/2TI	620320
R 5	RMF 150 85 W 1 CF CT	12126	M1/2TI	620050
R 6	RMF 750 85 W 1 CF CT	12126	M1/2TI	620250
R 7	RMF 750 85 W 1 CF CT	12126	M1/2TI	620250
R 8	RCOMP 47 10	01121	RC20	610030
R 9	RMF 750 85 W 1 CF CT	12126	M1/2TI	620250
R 10	RMF 1896 K 85 W 1 CF CT	12126	M1 1/2 T1	620402
R 11	RCOMP 470R 85 W10R RC2	01121	RCR20	610140
R 12	RCOMP 487 K 85 W10 RC20	01121	RC20	610250
R 13	RCOMP 1 K 85 W10R RC2	01121	RC20	610180
R 14	RCOMP 100R K 85 W10 RC2	01121	RC20	610290
R 15	RCOMP 1000R K 85 W10 RC2	01121	RCR20	610350
R 16	RCOMP 560R 85 W10R RC2	01121	RCR20	610150
R 17	RMF 402 85 W 1 CF CT	12126	M1/2TI	620140
R 18	RMF 1810 K 85 W 1 CF CT	12126	M5T1	620360
R 19	RMF 750 85 W 1 CF CT	12126	M1/2TI	620250
R 20	RMF 1896 K 85 W 1 CF CT	12126	M1 1/2 T1	620402
R 21	RMF 1896 K 85 W 1 CF CT	12126	M1 1/2 T1	620402

REFERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK #
R 22	RCOMP 330 .5W 10	01121	BC 20	610120
R 23	RMF 750 &5 W 1 CECT	12126	M1/2TI	620250
R 24	POT 250 1.5W	11236	DWG	600102
R 25	RMF 511 &5 W 1 CECT	12126	M1/2TI	620180
R 26	RMF 200 &5 W 1 CECT	12126	M1/2TI	620070
R 27	RLTC 508 38 W 38 1300	83125	1300S	630220
R 28	POT 150	11236	DRWG 099030-3	600071
R 29	POT 6 K 100 2W DUAL	12697	DRWG 098060-8	605040
R 30	POT 6 K 100 2W DUAL	12697	DRWG 098060-8	605040
R 31	RWW 3K 10W 5 LUG FR10		VALTO	640542
R 32	RWW 2.5 K	NGN	VAL5	640544
R 33	RCOMP 1 K &5 W108 RC2	01121	BC 20	610180
R 34	RCOMP 1 K &5 W108 RC2	01121	BC 20	610180
R 35	RCOMP 282 K &5 W108 RC20	01121	BC 20	610210
R 36	RCOMP4708 &5 W108 RC2	01121	BCB20	610140
R 37	RWW 150 50W 10 40	NGN	FR55	650575
R 38	RCOMP 100 10	01121	BC20	610070
R 39	POT 125 2 W10 R164	12697	DWG	600060
R 40	RMF 301 .5W 1	12126	M1/2TI	620110
R 41	POT 500 185 W 110	11236	DRWG 099030-5	600146
R 42	RWW 1.0 25W	NGN	FR25	650115
R 43	RMF 604 &5 W 1 CECT	12126	M1/2TI	620210
R 44	POT 250 1.5W	11236	DWG	600102
R 45	RLTC .2 3W 3	07088	KM300	630004

ELECTRICAL PARTS LIST -- HH50-1.0

REFERENCE		COMPONENT	MFR	MFR PART NUMBER	STOCK #
R	47	RWW 150 50W 1% 40	NSN	ER55	650575
S	1	SWITCH DPST 2PK63 73		ATL SWITCH 2PK63 73	880090
T	1	XFORMER HHT 50 1.0	09206	PRINT	509043

* ANY GOOD COMMERCIAL GRADE ELECTRICAL EQUIVALENT WHICH IS READILY AVAILABLE MAY BE USED.

REFERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK #
C 15	CAP , 8047 250V		MKT1813	800147
C 16	CAP .15MF 250V		MKT1813	800210
CR 20	DIODE ZENER IN 751A	81483	1N751A	720131
CR 21	DIODE ZENER IN4384	14936	G100C110	720384
CR 22	DIODE ZENER IN4384	14936	G100C110	720384
CR 23	DIODE ZENER IN4384	14936	G100C110	720384
CR 24	RECTIFIER 12AMP 100V	81483	IN3615	720132
CR 25	SCR C30F	0 81093	16C050C	720015
Q 20	TRANSISTOR 1S A507	03508	2N2714	700190
Q 21	TRANS 2N2905A	04713	2N2905	705067
Q 23	TRANS 2N2905A	04713	2N2905	705067
R 50	RMF 185 K 85 W 1 CFCT	12126	MST1	620350
R 51	RCOMP4708 85 W10R RC2	01121	RC920	610140
R 52	RCOMP 108 K 85 W10 RC2	01121	RC20	610290
R 53	RCOMP 487 K 85 W10 RC20	01121	RC20	610250
R 54	RCOMP 1 K 85 W10R RC2	01121	RC20	610190
R 55	POT 5 K 185 W20 110 0	11236	CRWG 099030-10	600290
R 56	RCOMP 1K .5W 10%	01121	RC20	610190

* ANY GOOD COMMERCIAL GRADE ELECTRICAL EQUIVALENT WHICH IS READILY AVAILABLE MAY BE USED.

E L E C T R I C A L P A R T S L I S T -- HH160-300

REFERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK #
C 1	CAP 500MF 75V 39D	56289	39D507G075HL4	810223
C 2	CAP .0017F 600V	33498	ACOM GP103P	800090
C 3	CAP .0033MF 600V CK62AW332	33498	GP332K	800025
C 4	CAP .001M600V	33498	GP102M	800006
C 5	CAP .0017F 600V	33498	ACOM GP103P	800090
C 6	CAP 1MF 250V METAL MYLAR		MKT1813	800304
C 7	CAP 15MF 25DV	56289	39D	810017
C 8	CAP 290MF 350V	90201	PRINT	820053
C 9	CAP 75MF 200V	56289	39D	810116
C 10	CAP 1.0MF 250V		MKT1813	800304
C 11	CAP 34MF 15V TYPE TTXE	90201	TTXF	810057
C 12	CAP .0017F 600V	33498	ACOM GP103P	800090
C 13	CAP .47MF-40V		MKT1813	800295
CR 1	DIODE 1N4384	14936	G100G110	720384
CR 2	DIODE 1N4384	14936	G100G110	720384
CR 3	DIODE IN1360A	91483	1N1360A	720241
CR 4	DIODE ZENER 1N751A	81483	1N751A	720181
CR 5	DIODE 1N2163A	24444	IN2163A	720262
CR 6	DIODE 1N4384	14936	G100G110	720384
CR 7	DIODE 1N4384	14936	G100G110	720384
CR 8	DIODE 1N4384	14936	G100G110	720384
CR 9	DIODE 1N4384	14936	G100G110	720384
CR 10	DIODE 12AMP 600V	81483	1N1206A	720137
CR 11	DIODE 12AMP 600V	81483	1N1206A	720137

E L E C T R I C A L P A R T S L I S T -- HH160-300

REFERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK #
CR 12	DIODE 1N4585	05828	1N4585	720383
CR 13	DIODE 1N4585	05828	1N4585	720383
CR 14	DIODE 1N4384	14936	G100G110	720384
CR 15	DIODE 1N4384	14936	G100G110	720384
CR 16	DIODE 1N4733A	04713	1N4733A	720388
CR 17	DIODE 1N4384	14936	G100G110	720384
CR 18	DIODE 1N4384	14936	G100G110	720384
CR 19	DIODE 1N4384	14936	G100G110	720384
CR 27	DIODE 1N4384	14936	G100G110	720384
DS 1	PILOT LIGHT REDLENS	91802	2110814	770028
DS 2	LIGHT IND 41N 66 1317 985T	91802	2190A87	770023
F 1	FUSE 2 AMP MDX	71400	MDX2A	870170
M 1	METER .5A-TNT-MS1T	33005	MS1T	750387
M 2	METER 200 VOLT-MS1T	33005	MS1T	752652
P 1	LINE CORD 18-3	*		921000
Q 1	TRANS 16A507	03508	2N2714	700180
Q 1	TRANS 2N3566	30045	2N3566	700182
Q 1	TRANS DTS 411		DTS411	700429
Q 2	TRANS 2N2905A	04713	2N2905	705067
Q 3	TRANS 16A507	03508	2N2714	700180
Q 4	TRANS 16A507	03508	2N2714	700180
Q 5	TRANS 16A507	03508	2N2714	700180
Q 6	TRANS 2N2905A	04713	2N2905	705067
Q 7	TRANS 16A507	03508	2N2714	700180

E L E C T R I C A L P A R T S L I S T -- HH 160-300

REFERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK #
Q 8	TRANS 16A507	03508	2N2714	700180
Q 9	TRANS 2N3566	30045	2N3566	700182
Q 11	TRANS DTS 411		DTS411	700429
Q 13	TRANSISTOR	30045	DPWG	700196
Q 200	TRANS DTS 411		DTS411	700429
R 1	RWW 200Ω 5% WW5% 5X20		VAL5	640399
R 2	RMF 9895 K 85 W 1 CECT	12126	M1/2TI	620600
R 3	RCOMP 47Ω K 85 W10 RC2	01121	RCR20	610340
R 4	RMF 1818 K 85 W 1 CECT	12126	M1/2TI	620320
R 5	RMF 174 85W 1 CECT	12126	M1/2T1	620055
R 6	RMF 750 85 W 1 CECT	12126	M1/2TI	620250
R 7	RMF 750 85 W 1 CECT	12126	M1/2TI	620250
R 8	RCOMP 100 .5W 10%	01121	RC20	610070
R 9	RMF 750 85 W 1 CECT	12126	M1/2TI	620250
R 10	RMF 1896 K 85 W 1 CECT	12126	M1 1/2 T1	620402
R 11	RCOMP 3.3K .5W 10%	01121	RC20	610230
R 12	RCOMP 487 K 85 W10 RC20	01121	RC20	610250
R 13	RCOMP 1K .5W 10%	01121	RC20	610180
R 14	RCOMP 2.7K-.5W-10%	*	RC20	610226
R 15	RCOMP1008 K 85 W10 RC2	01121	RCR20	610350
R 16	RCOMP560Ω 85 W10Ω RC2	01121	RCR20	610150
R 17	RMF 402 85 W 1 CECT	12126	M1/2TI	620140
R 18	RMF 185 K 85 W 1 CECT	12126	M5T1	620360
R 19	RMF 750 85 W 1 CECT	12126	M1/2TI	620250

REFERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK #
R 20	RMF 1896 K 85 W 1 CECT	12126	M1 1/2 T1	620402
R 21	RMF 1896 K 85 W 1 CECT	12126	M1 1/2 T1	620402
R 22	RCOMP 330 .5W 10%	01121	RC20	610120
R 23	RMF 750 85 W 1 CECT	12126	M1/2TI	620250
R 24	POT 250 1.5W 110	11236	DWG	600102
R 25	RMF 1.13K 85W 1CECT	12126	M1/2T1	620316
R 26	RMF 64.9 85W 1 CECT	12126	M1/2T1	620006
R 27	RLTC 500 3W 3%	00213	1300S	630340
R 28	POT 150 1.5W 110	11236	DRWG 099030-3	600071
R 29	POT 40K 1K 2W DUAL	12697	PRINT	605150
R 30	POT 40K 1K 2W DUAL	12697	PRINT	605150
R 31	RWW 6K 10W	NGN	VAL10	640559
R 32	RWW 12K 5W 5% 5XM	*	243F	640572
R 36	RCOMP 1K .5W 10%	01121	RC20	610180
R 37	RWW 1.5K 50W	NGN	FR55	650742
R 38	RCOMP 100 .5W 10%	01121	RC20	610070
R 39	POT 125 2 W10 B164	12697	DWG	600060
R 40	RMF 374 85W 1 CECTO	12126	M1/2T1	620135
R 41	POT 500 185 W 110	11236	DRWG 099030-5	600146
R 42	RWW3 25W 2D	NGN	FR25	650205
R 43	RMF 604 85 W 1 CECT	12126	M1/2TI	620210
R 47	RWW 1.5K 50W	NGN	FR55	650742
R 48	RWW 6K 10W	NGN	VAL10	640559
R 49	RCOMP 47 .5W 10%	01121	RCR20	610030

ELECTRICAL PARTS LIST -- HH150-300

REFERENCE		COMPONENT	MFR	MFR PART NUMBER	STOCK #
R	50	RCOMP 680 .5W 10%	01121	BC20	610160
R	51	RWW 300 5W 10%		VAL5	640420
R	52	RCOMP 470 .5W 10%	01121	BC20	610140
R	53	RCOMP 150K-.5W-10%	01121	BC20	610360
S	1	SWITCH DPST 28K63 73		ATL SWITCH 28K63 73	880090

* ANY GOOD COMMERCIAL GRADE ELECTRICAL EQUIVALENT WHICH IS READILY AVAILABLE MAY BE USED.

E L E C T R I C A L P A R T S L I S T -- MM32-1.5

REFERENCE	COMPONENT			MFR	MFR PART NUMBER	STOCK #
C 1	CAP 500MF 75V 39D		O	56289	39D507G075HL4	810223
C 2	CAP 8017F 600V			33498	ACOM GP103P	800090
C 3	CAP 80033MF 600V	CK62AW332		33498	GP332K	800025
C 4	CAP 8001M600V			33498	GP102M	800006
C 5	CAP 8017F 600V			33498	ACOM GP103P	800090
C 6	CAP 1MF 250V METAL MYLAR				MKT1813	800304
C 7	CAP 21 MF 125V			90201	TTXE	810041
C 8	CAP 2800MF 75V 86F	WMYLA		00835	DWG	820177
C 9	CAP 1500MF 50V 39D			56289	39D158G050JP4	819955
C 10	CAP 10MF 50V TTXE			90210	TTX106N050A0LIP	810010
C 11	CAP 34MF 15V TYPE TTXE			90201	TTXE	810057
C 12	CAP 8017F 600V			33498	ACOM GP103P	800090
CR 1	DIODE ZENER	IN4384	O	14936	G100G110	720384
CR 2	DIODE ZENER	IN4384	O	14936	G100G110	720384
CR 3	DIODE IN1360A			81483	1N1360A	720241
CR 4	DIODE ZENER IN 751A			81483	1N751A	720181
CR 5	DIODE 1N2163A			24444	IN2163A	720262
CR 6	DIODE ZENER	IN4384	O	14936	G100G110	720384
CR 7	DIODE ZENER	IN4384	O	14936	G100G110	720384
CR 8	DIODE ZENER	IN4384	O	14936	G100G110	720384
CR 9	DIODE ZENER	IN4384	O	14936	G100G110	720384
CR 10	DIODE 12 AMP 200V			81093	DRWG	720131

E L E C T R I C A L P A R T S L I S T -- HH32-1.5

REFERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK #
CR 11	DIODE 12 AMP 200V	81093	DRWG	720131
CR 12	DIODE ZENER IN4384	0 14936	GI006110	720384
CR 13	DIODE ZENER IN4384	0 14936	GI006110	720384
CR 14	DIODE ZENER IN4384	0 14936	GI006110	720384
CR 15	DIODE ZENER IN4384	0 14936	GI006110	720384
CR 16	DIODE ZENER IN 751A	81483	1N751A	720181
CR 17	DIODE ZENER IN4384	0 14936	GI006110	720384
CR 18	DIODE TR 4148	21845	1N4148	720440
CR 27	DIODE 1N4384	14936	GI006110	720384
DS 1	PILOT LIGHT REDLENS	91802	2110B14	770028
DS 2	LIGHT IND 41N 66 1317 985T	91802	2190A87	770023
F 1	FUSE 5AMP MDX 125V	71400	MDL10A	870200
M 1	METER 1.5AMP MSIT	33005	MS1T	750300
M 2	METER 40VOLT MSIT	33005	MS1T	752620
P 1	LINE CORD 18-3	*		921000
Q 1	TRANSISTOR 16 A507	03508	2N2714	700180
Q 2	TRANS 2N2905A	04713	2N2905	705067
Q 3	TRANSISTOR 16 A507	03508	2N2714	700180
Q 4	TRANSISTOR 16 A507	03508	2N2714	700180
Q 5	TRANSISTOR 16 A507	03508	2N2714	700180
Q 6	TRANS 2N2905A	04713	2N2905	705067
Q 7	TRANSISTOR 16 A507	03508	2N2714	700180

REFERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK #
Q 8	TRANSISTOR 16 A507	03508	2N2714	700180
Q 9	TRANSISTOR 16 A507	03508	2N2714	700180
Q 10	TRANSISTOR 16 A507	03508	2N2714	700180
Q 11	TRANSISTOR TR1493	30045	OWG	700083
Q 12	TRANSISTOR TR1493	30045	OW6	700083
Q 13	TRANSISTOR TR1591	30045	ORW6	700191
Q 14	TRANS 2N2219A	05828	2N2219A	705068
R 1	RWW 2008 5% WW5% 5X20		VAL5	640389
R 2	RMF 9895 K 85 W 1 CECT	12126	MI/2TI	620600
R 3	RCOMP 478 K 85 W10 RC2	01121	RCR20	610340
R 4	RMF 1818 K 85 W 1 CECT	12126	MI/2TI	620320
R 5	RMF 150 85 W 1 CECT	12126	MI/2TI	620050
R 6	RMF 750 85 W 1 CECT	12126	MI/2TI	620250
R 7	RMF 750 85 W 1 CECT	12126	MI/2TI	620250
R 8	RCOMP 47 85 W10% RC2	01121	R620	610030
R 9	RMF 750 85 W 1 CECT	12126	MI/2TI	620250
R 10	RMF 1896 K 85 W 1 CECT	12126	MI 1/2 T1	620402
R 11	RCOMP4708 85 W10% RC2	01121	RCR20	610140
R 12	RCOMP 487 K 85 W10 RC20	01121	RC20	610250
R 13	RCOMP 1 K 85 W10% RC2	01121	RC20	610180
R 14	RCOMP 10% K 85 W10 RC2	01121	RC20	610290
R 15	RCOMP100% K 85 W10 RC2	01121	RCR20	610350

E L E C T R I C A L P A R T S L I S T -- HH32-1.5

REFERENCE	COMPONENT		MFR	MFR PART NUMBER	STOCK #
R 16	RCOMP560Ω	5% W10% RC2	01121	RCR20	610150
R 17	RMF 402	5% W 1 CECT	12126	M1/2TI	620140
R 18	RMF 185 K	5% W 1 CECT	12126	M5T1	620360
R 19	RMF 750	5% W 1 CECT	12126	M1/2TI	620250
R 20	RMF 1896 K	5% W 1 CECT	12126	M1 1/2 T1	620402
R 21	RMF 1896 K	5% W 1 CECT	12126	M1 1/2 T1	620402
R 22	RCOMP100Ω	5% W10% RC2	01121	RC20	610070
R 23	RMF 750	5% W 1 CECT	12126	M1/2TI	620250
R 24	POT 150	10% W 110	11236	DRWG 099030-3	600071
R 25	RMF 511	5% W 1 CECT	12126	M1/2TI	620180
R 26	RMF 200	5% W 1 CECT	12126	M1/2TI	620070
R 27	RLTC 50Ω	3% W 3% 1300	83125	1300S	630220
R 28	POT 150	10% W 110	11236	DRWG 099030-3	600071
R 29	POT 3%5K100 2W DUAL B6813		12697	DWG	605025
R 30	POT 3%5K100 2W DUAL B6813		12697	DWG	605025
R 31	RWW 3K 10W 5 LUG FR10			VALIO	640542
R 32	RWW 1K-5W-5%			VAL5	640510
R 33	RCOMP 1 K	5% W10% RC2	01121	RC20	610180
R 34	RCOMP 1 K	5% W10% RC2	01121	RC20	610180
R 35	RCOMP 2Ω2 K	5% W10% RC20	01121	RC20	610210
R 36	RCOMP470Ω	5% W10% RC2	01121	RCR20	610140
R 37	RWW 70 50W 5 12 56RX			MEMCOR FR50	650495

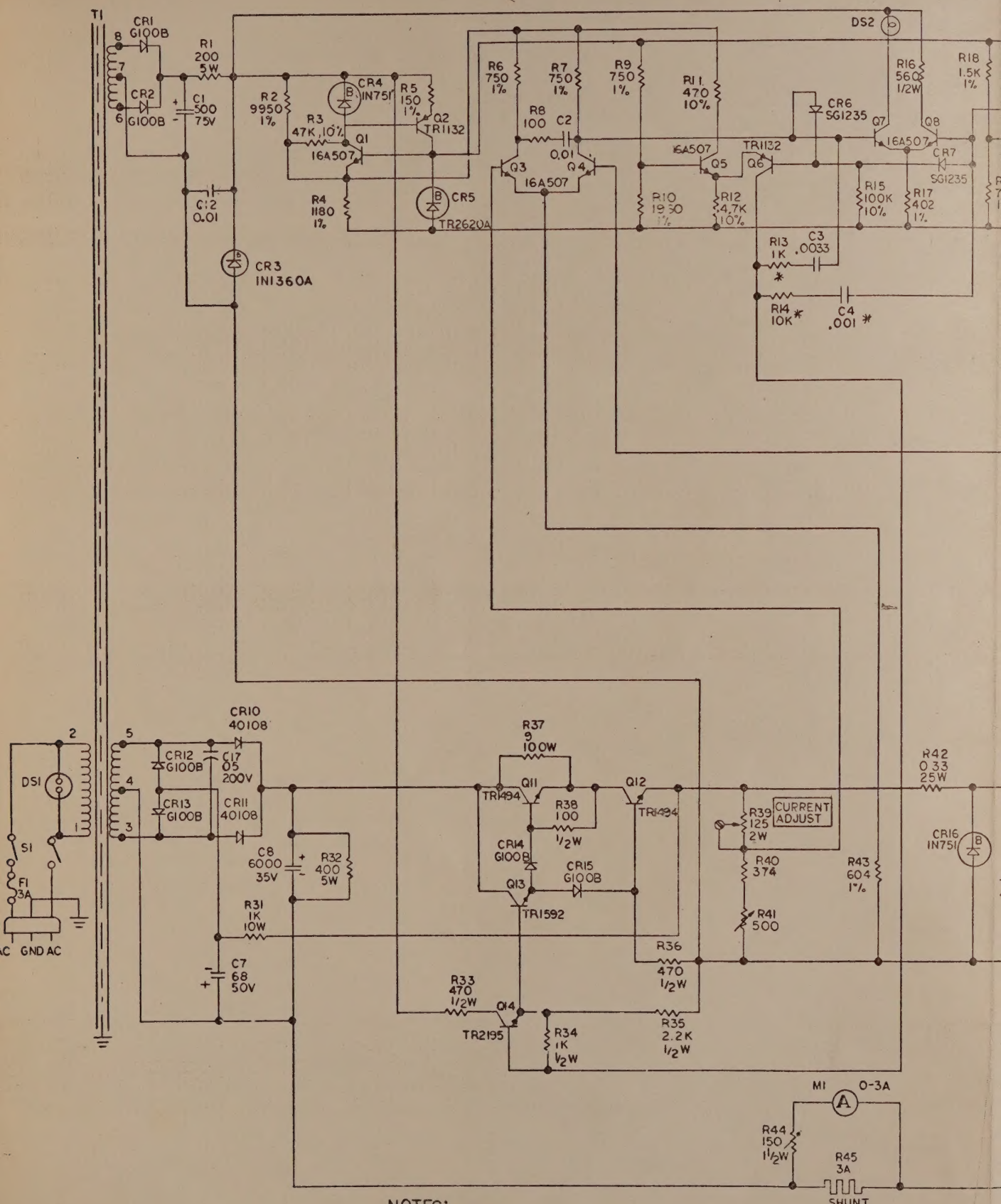
REFERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK #
R 38	RCOMP100& 85 W10& RC2	01121	R620	610070
R 39	POT 125 2 W10 B164	12697	DWG	600060
R 40	RMF 374 85W 1 CECTO	12126	M1/2T1	620135
R 41	POT 500 1&5 W 110	11236	DRWG 099030-5	600146
R 42	RWW 867 25W 20		MEMCOR FR25	650095
R 43	RMF 604 85 W 1 CECT	12126	M1/2TI	620210
R 44	POT 150 1&5 W 110	11236	DRWG 099030-3	600071
R 47	RWW 70 50W 5 12 56RX		MEMCOR FR50	650495
S 1	SWITCH DPST 28K63 73		ATL SWITCH 28K63 73	880090
T 1	XFORMER HHT 32 1&5	0 09206		509040

* ANY GOOD COMMERCIAL GRADE ELECTRICAL EQUIVALENT WHICH IS READILY AVAILABLE MAY BE USED.

ELECTRICAL PARTS LIST -- HH32-1.50V

REFERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK #
C 15	CAP .0047 250V		MKT1813	800147
C 16	CAP .15MF 250V		MKT1813	800210
CR 20	DIODE ZENER IN751A	81483	1N751A	720181
CR 21	DIODE FENER IN4384	14936	G100G110	720384
CR 22	DIODE FENER IN4384	14936	G100G110	720384
CR 23	DIODE FENER IN4384	14936	G100G110	720384
CR 24	DIODE 12 AMP 50V	22888	DRWG	720129
CR 25	SCR C30F	0 81093	16C050C	720015
Q 20	TRANSISTOR 16A507	03508	2N2714	700180
Q 21	TRANS 2N2905A	04713	2N2905	705067
Q 23	TRANS 2N2905A	04713	2N2905	705067
R 50	RMF 185 K .5 W 1 CECT	12126	MST1	620360
R 51	RCOMP4708 .5 W108 RC2	01121	RCR20	610140
R 52	RCOMP 108 K .5 W10 RC2	01121	RC20	610290
R 53	RCOMP 487 K .5 W10 RC20	01121	RC20	610250
R 54	RCOMP 1 K .5 W108 RC2	01121	PC20	610180
R 55	POT 5 K 1.5 W20 110 0	11236	DRWG 099030-10	600290

* ANY GOOD COMMERCIAL GRADE ELECTRICAL EQUIVALENT WHICH IS READILY AVAILABLE MAY BE USED.

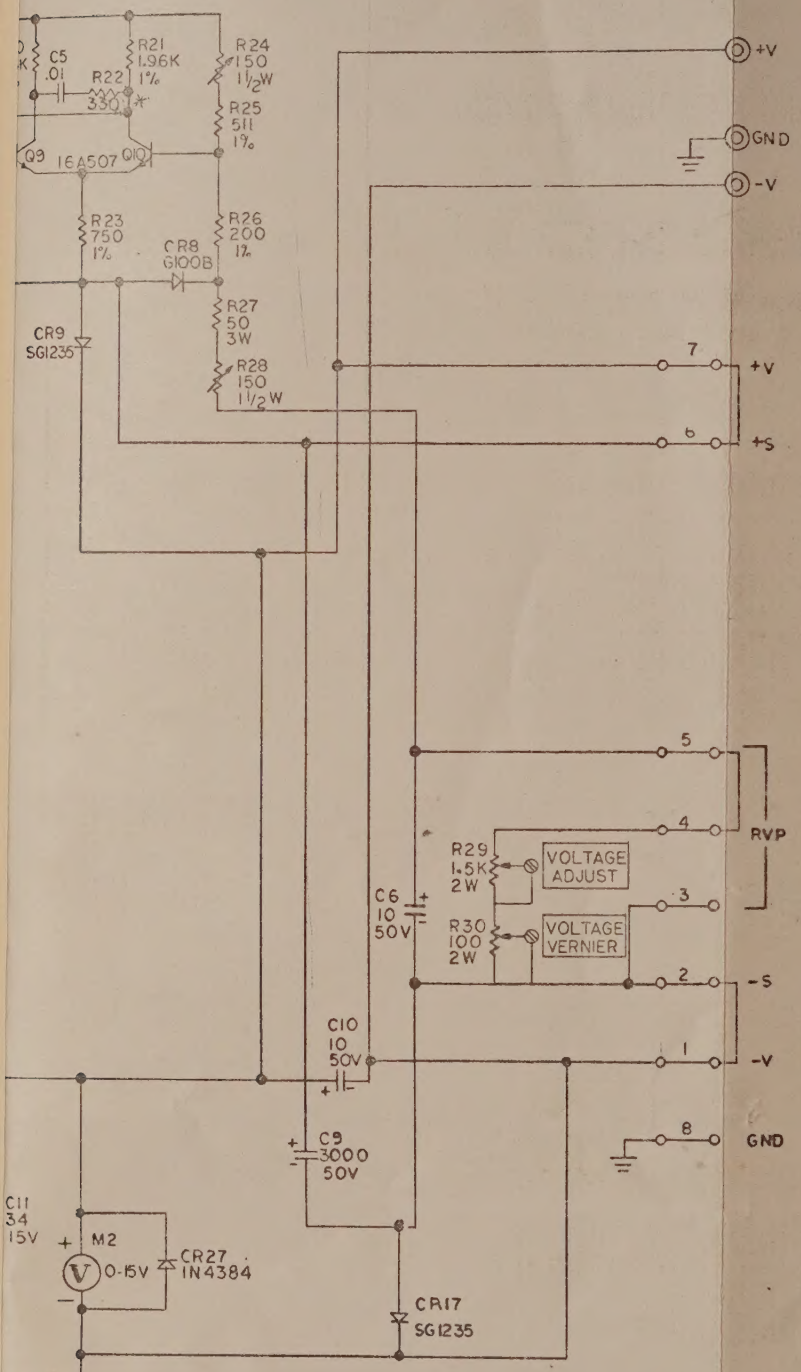


NOTES:

UNLESS OTHERWISE SPECIFIED
ALL RESISTORS IN OHMS, 1/2W.
ALL CAPACITOR IN MICROFARADS.

2. TRANSISTOR 700083 MAY BE USED AS AN A
TR1590 & TR1592.

REVISIONS				
SYM	ZONE	DESCRIPTION	DATE	APPROVED
A		CR3 WAS URB24 - ECN No 3173	5-28-67	
B		TITLE WAS HH 4-3 - ECN No 4183	11-27-68	
C		ADDED CR27 - ECN 5238	3-24-71	
D		ADDED C17 ECN# 5422	12-13-71	



QTY REQD	SYM	NOMENCLATURE OR DESCRIPTION	CODE IDENT	PART OR IDENTIFYING NO.	SPECIFICATION	MATERIAL OR NOTE	UNIT WT	ZONE	ITEM NO.

LIST OF MATERIALS OR PARTS LIST

ERNATE FOR

NEXT ASSY	USED ON		
APPLICATION			

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES

MATERIAL:

FINISH:

DRAW NO STARTED G. PRIM. DATE 7-2-65

DRAWN

CHECKED

ENGR

STD.

TRYGON ELECTRONICS INC.
ROOSEVELT NEW YORK

MODEL HH 15-3

SCHEMATIC

CODE IDENT NO.	SIZE		REV
09206	D	6987	D

SCALE — SHEET 1 of 1

3 2 1

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